

CHAPTER 1 INTRODUCTION

1-1. Purpose. This document provides technical information for designing and constructing air stripping systems. Example designs are provided in the appendices. Basic information about air strippers can be found in the Tri-Service sponsored *Remediation Technologies Screening Matrix and Reference Guide*, <http://www.frtr.gov>.

1-2. Definition. Air strippers remove volatile organic chemicals (VOCs) from liquid (water) by providing contact between the liquid and gas (air). The gas (air) may then be released to the atmosphere or treated to remove the VOCs and subsequently released to the atmosphere.

1-3. Scope. This document describes packed column, low-profile sieve tray and diffused aeration air strippers. Steam stripping is not included. This document discusses the three types, compares them, and lists advantages and disadvantages of each type to provide information for selection. Design examples for the packed-column and the low-profile air stripper are included in the appendices.

1-4. Theory. Air stripping is the mass transfer of VOCs that are dissolved in water from the water phase to the air phase. The equilibrium relationship is linear and is defined by Henry's Law (Kavanaugh and Trussell, 1980; Shulka and Hicks, 1984). For low concentrations of volatile compound a :

$$p_a = H_a x_a$$

a . At equilibrium, the partial pressure of a gas, p_a , above a liquid is directly proportional to the mole fraction of the gas, x_a , dissolved in the liquid. The proportionality constant, H_a , is known as the Henry's constant. The value of the constant generally increases or decreases with the liquid temperature (Plambeck, 1995). As a consequence, the solubility of gases generally decreases with increasing temperature (Plambeck, 1995). EPA (1998) has published a comprehensive document, *Henry's Law Constants, Fm Values, Fr Values and Fe Values for Organic Compounds*, at http://www.epa.gov/ttn/oarpg/tl/fr_notices/appj.pdf. Practical application of the technology for contaminant removal is generally limited to compounds with Henry's constant values greater than 100 atmospheres. The theory is developed in textbooks such as McCabe et al. (1993) and Treybal (1980).

Table 1-1
Molar Henry's Law Constants at 293.16 K

<i>Contaminant</i>	<i>[atm-m³/mole]</i>	<i>[Pa-m³/mole]</i>	<i>[Dimensionless]</i>
2,4 - D	1.02×10 ⁻⁸	1.03×10 ⁻³	7.65×10 ⁻⁹
alachlor	3.20×10 ⁻⁸ to 1.20×10 ⁻¹⁰	3.24×10 ⁻³ to 1.22×10 ⁻⁵	2.40×10 ⁻⁸ to 9.00×10 ⁻¹¹
aldicarb, aldicarb sulfone and aldicarb sulfoxide	1.50×10 ⁻¹⁰	1.52×10 ⁻⁴	1.13×10 ⁻⁹
atrazine	2.63×10 ⁻⁹	2.66×10 ⁻⁴	1.97×10 ⁻⁹
carbofuran	1.02×10 ⁻¹⁰	1.03×10 ⁻⁵	7.65×10 ⁻¹¹
chlordane (gamma-chlordane)	1.30×10 ⁻³	132	9.75×10 ⁻⁴
dalapon	6.30×10 ⁻⁸	6.38×10 ⁻³	4.73×10 ⁻⁸
dibromochloropropane (DBCP)	1.47×10 ⁻⁴	14.9	1.10×10 ⁻⁴
di (2-ethylhexyl) adipate	4.34×10 ⁻⁷	4.40×10 ⁻²	3.26×10 ⁻⁷
di (2-ethylhexyl) phthalate (DEHP)	1.00×10 ⁻⁴	10.1	7.50×10 ⁻⁵
dinoseb	5.04×10 ⁻⁴	51.1	3.78×10 ⁻⁴
dioxin (2,3,7,8-TCDD)	1.62×10 ⁻⁵	1.64	1.22×10 ⁻⁵
endrin	4.00×10 ⁻⁷	4.05×10 ⁻²	3.00×10 ⁻⁷
hexachlorobenzene (HCB)	3.00×10 ⁻² to 7.00×10 ⁻²	3.04×10 ⁺³ to 7.09×10 ⁺³	2.25×10 ⁻² to 5.25×10 ⁻²
heptachlor and heptachlor epoxide	2.62×10 ⁻³	265	1.97×10 ⁻³
hexachlorocyclopentadiene (hex)	2.70×10 ⁻²	2.74×10 ⁺³	2.03×10 ⁻²
methoxychlor	1.60×10 ⁻⁵	162	1.20×10 ⁻⁵
polychlorinated biphenyls (PCBs)	5.00×10 ⁻⁵ to 3.30×10 ⁻⁴	5.1 to 33.44	3.75×10 ⁻⁵ to 2.48×10 ⁻⁴
simazine	4.63×10 ⁻¹⁰	4.69×10 ⁻⁵	3.47×10 ⁻¹⁰
toxaphene	5.00×10 ⁻³ to 6.30×10 ⁻²	507 to 6.38×10 ⁺³	3.75×10 ⁻³ to 4.73×10 ⁻²
http://www.epa.gov/OGWDW/dwh/t-soc/chemical_name_(i.e._24-D,_alachlor...).html			
The molar density of water at 293.160 K, C ₀ = 55.41 kg-mole/m ³			
The universal gas constant, R = 8.3145 Pa-m ³ /kg mol- K			
1 Pa = 9.86923 × 10 ⁻⁶ atm			

b. Units, as defined by Henry's law, as stated, are standard atmospheres [atm] with the concentration of the solute given as the mole fraction of the solution. Practical application of Henry's law has resulted in corruption of the units to the point of confusion, as seen in Table 1-1.